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The effect of dominance by an alien grass species, Lehmann lovegrass, *Eragrostis lehmanniana*, on faunalpedoturbation patterns in North American Desert grasslands

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Abstract

We examined the effects of an alien species, Lehmann lovegrass (*Eragrostis lehmanniana*), on the semi-arid grassland ecosystems of the south-western United States. In order to evaluate these effects, we examined soil disturbance by animals in areas dominated by Lehmann lovegrass in comparison with areas dominated by native grasses. We measured amounts and types of faunalpedoturbation at paired plots in two different study areas, the Jornada basin in New Mexico and the Santa Rita Experimental Range in south-eastern Arizona. Area of soil disturbed and volume of soil turnover was significantly decreased on plots dominated by Lehmann lovegrass, at the Santa Rita Experimental Range but not on plots in the Jornada basin. At the Santa Rita, ground squirrels and attine ant activity was reduced the most of any other species in Lehmann lovegrass dominated pastures. Differences in the diversity of disturbances were inconsistent at both study areas indicating variable responses by taxa to dominance by an alien grass species. Variations among, within, and between study areas were attributed to site history as well as geographic and topographic position. The degree to which Lehmann lovegrass affects faunalpedoturbation appears to be related to the history of the site, specifically the time since the establishment of Lehmann lovegrass.

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1. Introduction

The vegetation of the desert grasslands in the southwest United States has undergone dramatic changes since the 1800s, mainly the disappearance of native grasslands and increases in brush and scrubby trees (Bahre, 1995, pp. 230–264). Due to unsuccessful restoration of native vegetation by early range managers, non-native plants were introduced (Roundy and Biedenbender, 1995, pp. 265–303). Introductions of non-native species have the potential to affect greatly the properties and processes of the ecosystems into which they are introduced. Changes in ecosystem properties such as community composition, productivity, resilience, soil characteristics, and changes in processes such as nutrient cycling, water flux and disturbance may accompany structural changes associated with invasive species (Vitousek, 1986, pp. 163–187). Lehmann lovegrass (*Eragrostis lehmanniana*) is a short-lived, small seeded grass native to the semiarid lands in the Northern Cape of South Africa. Lehmann lovegrass is found in many different soil and moisture conditions in most of South Africa (Cox and Ruyle, 1986). In South Africa, *E. lehmanniana* replaces large seeded perennial grasses which have been reduced by grazing (Milton et al., 1999). The ability of Lehmann lovegrass to thrive in many different conditions in its native land contributes to its success in the south-western United States. It was first planted in southern Arizona on the Santa Rita Experimental Range in 1937 and was subsequently planted in various areas around the south-western United States and northern Mexico (McClaran, 1995). This grass was seeded by the Soil Conservation Service to revegetate overgrazed lands and conserve soil (Crider, 1945). Lehmann lovegrass is well suited to the south-western United States and has spread to an almost “naturalized state” (Anable et al., 1992).

Few studies have examined the effects that community dominance by Lehmann lovegrass has on native faunal communities and ecosystem processes. Bock et al. (1986) found the presence of Lehmann lovegrass and another South African grass, Boer lovegrass (*E. curvula* var. *conferta*) decreased the presence of native grasses as well as a certain species of grasshoppers, rodents, and birds on the Appleton-Whittell Research Sanctuary in Santa Cruz county, south-eastern Arizona. Whitford et al. (1999) found that large, seed harvester ants, *Pogonomyrmex* spp., abundance was greatly reduced in stands dominated by Lehmann lovegrass when compared with native grass stands. However there were no differences in species richness or relative abundance of other species of ants.

Faunalpedoturbation is defined as soil mixing by animals (Hole, 1961). The importance of soil disturbance by animals in soil formation has long been recognized (Darwin, 1882). Organisms play a fundamental role in soil formation (Jenny, 1941). Soil disturbance by animals not only affects soil formation, it affects many ecosystem processes in arid and semi-arid ecosystems. Soil disturbed by animals contributes to spatiotemporal heterogeneity of water content and nutrient concentrations across the landscape. Pits dug by animals trap litter and soil and may have increased infiltration. These pits are often germination sites for plants. Trapped litter is an important source of organic matter in the soil, especially in arid environments where surface litter adds very little to soil organic matter (Whitford and Kay, 1999). Voids

in the soil created by termites, ants, beetle and cicadas serve as macropores and may increase infiltration (Whitford, 2000). Soil moved by termites, ants, rodents and badgers transport deep horizon material to the surface and in some instances, redistribute certain particle sizes allowing surface materials to reach deep layers of the soil (Johnson and Watson-Stegner, 1987; Whitford and Kay, 1999). Redistribution of soil materials by animals may result in a biomantle. Biomantles are differentiated zones of soil where there is a loss of fine particles and redistribution of coarse particles caused mainly by faunal activity (Johnson, 1990).

If dominance by an alien grass such as Lehmann lovegrass adversely impacts some of the animal species in the grassland ecosystem, studies of animal produced soil disturbance patterns can provide an assessment of the magnitude of the impact and some quantitative information on the animal species that are affected. By identifying and quantifying soil disturbed by animals, we are able to assess not only the diversity of animals active in the ecosystem but also the level of animal activity. Although these measurements do not allow us to determine the number of individuals active in these ecosystems, the amount of soil disturbed indicates the relative level of activity by individuals or groups of individuals. In this study, we measured the quantity of soil disturbed by animals and the types of soil disturbance in plots dominated by Lehmann lovegrass and plots dominated by native grasses in paired plots at two different study areas. We hypothesized that the amount of soil disturbed (area and volume) and diversity of soil disturbance by animals would be less in Lehmann lovegrass dominated plots.

2. Study area

This study was conducted on two different study areas, the Santa Rita Experimental Range (SRER) in Arizona and on two research stations in the Jornada Basin of New Mexico. The Santa Rita is approximately 40 km south of Tuscon, Arizona in the ecotone between the Sonoran and Chihuahuan desert grasslands (Fig. 1). The elevation ranges from 900 to 1300 m. Rainfall, 250–500 mm per year, varies with elevation. A majority of the rainfall, 50–60%, occurs between July and September. Mean annual temperature at higher elevations is 16°C. The range is in the American Semi-Desert Province (Bailey, 1995). The vegetation, semi-desert grassland, is dominated by Sonoran species due warm temperatures. Lehmann lovegrass and velvet mesquite (*Prosopis velutina*) have increased since the late nineteenth and early twentieth centuries (McClaran, 1995). The range is at the northwestern edge of the Santa Rita Mountains. The topography consists of gently sloping alluvial fans, small buttes and steep stony foothills. Soils are mainly Aridisols, with some Mollisols and Entisols (McClaran, 1995). Six plots were selected by random stratification on the Santa Rita, three of which were dominated by native grasses and three of which were dominated by Lehmann lovegrass. These plots are all located on the alluvial fan mosaic of the Santa Rita Piedmont. The coarse textured soils exhibit both argillic and calcic horizons. The degree of development varies with position and age (McAuliffe, 1995). All plots are within the

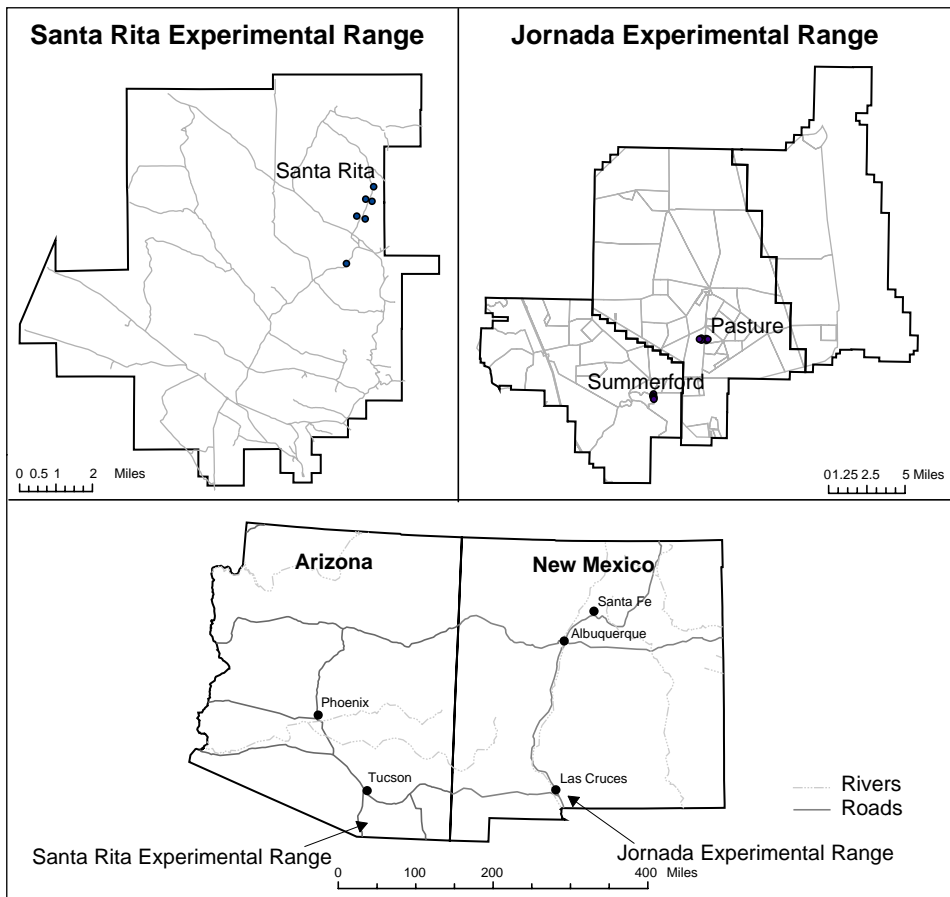


Fig. 1. Study locations. Upper panels show locations of plots at the Santa Rita and the New Mexico Experimental Rangelands. Lower panel shows the locations of the experiment stations within the states.

sandy loam and sandy loam upland soils as defined by the Natural Resource Conservation Service Ecological Site Survey (McClaran et al., 2002). The soils on the plots are classified as either the Sasabe-Baboquivari complex, which consists of very deep, well drained soils formed in fan alluvium with sandy loam or coarse sandy loam textures, or within the Combate-diaspar complex, which consists of very deep, well drained soils formed in fan alluvium with coarse loamy texture (McClaran et al., 2002).

The other two sites were on the USDA-ARS Jornada Experimental Range (JER) and the adjacent Chihuahuan Desert Rangeland Research Center (CR), approximately 40 km north of Las Cruces, New Mexico (Fig. 1). The elevation ranges from 1200 to 1400 m. Average annual precipitation is around 210 mm with 50% percent or more occurring between July and September. Average annual temperature is about 15°C. This area is within the Chihuahuan Semi-Desert Province (Bailey, 1995). The

vegetation, desert grassland, has experienced major vegetation change over the past 100 years, mainly the encroachment of honey mesquite (*P. glandulosa*) (McClaran, 1995). The topography is typical of basin and range province with the San Andreas Mountains in the east and the Dona Ana Mountains in the west. The major landforms in the area are piedmont slopes consisting of alluvial fans, interfan valleys, minor rock pediments, coalescent-fan piedmonts and basin floors with small playa-lake depressions and extensive alluvial plains (Gile et al., 1999). The soils are coarse textured and exhibit both argillic and calcic horizons.

At each study site, three plots dominated by native grasses were paired with three plots with varying presence of Lehmann lovegrass. One set of six plots were at the base of Summerford Mountain on the Chihuahuan Desert Rangeland Research Center. These plots were all on the upper alluvial fan surface at the immediate base of Summerford Mountain. The soils here are classified as the Onite-Pajarito association which consists of very deep, well-drained soils that formed in old alluvium derived mainly from acid igneous rocks with a coarse loamy texture. These soils have coarse fragments at the surface. Another set of six plots were located in Pasture 12B on the Jornada Experimental Range. These plots are located lower in basin on the coalscent-fan piedmonts. The soils are classified as the Berino-Bucklebar association consisting of very gently sloping to gently sloping soils on broad fans with fine-loamy texture (Bullock and Neher, 1980).

Lehmann lovegrass was planted at the New Mexico sites in the 1950s and was planted on the Santa Rita in the late 1930s. The Summerford study site has not been grazed by domestic livestock. The pasture study site has been grazed at varying intensities since 1915. The study areas were chosen because their history is well-known and because both contain communities of native grasses and Lehmann lovegrass. Several criteria were used when selecting the sites. Sites must be selected that had both native and Lehmann communities close together (i.e. less than 2 miles apart). These communities must also be at similar elevations, geomorphic positions, soil types and climates. These criteria attempted to minimize the influence of physical factors (i.e. soils and climate) on animal activity within one study site or set of plots. Minimizing physical influence across study sites or study areas was not possible therefore statistical comparisons are made only with sites and not across sites. The number locations where this criterion could be met limited the number of sites in the study.

3. Methods

The centers of each of the 18–10 m radius plots were marked with rebar. This size was used in order to sample the range of activities occurring in each community. At each sample date, the circumference of a plot was identified by flagging. All soil disturbances within a plot were measured and the responsible agent was identified and recorded. Two diameters of the disturbances, at the major and minor axes, as well as a heights or depths were measured depending on the type of disturbance. Disturbances were assigned to a category (animal species, or type of disturbance)

based on the shape and size of the disturbance. The categories were: disturbance by ants, ejecta including all soil discharged by digging or foraging, foraging including all pits dug by rodents, rodent burrows, and termite constructed galleries and sheeting. Detailed descriptions of biopedoturbation types, the species which produce them and their biological feedbacks are in Jackson et al. (2003). Data were collected during the months of March, May, July, September and November. Because of disturbance by large numbers of livestock in the pasture plots, no data were collected from these plots in November. Vegetation cover and species composition were estimated at each plot by a modified line-intercept method (Whitford et al., 1998). Three, 30 m lines were established at random compass bearings from the center of the each of the six plots per site.

The estimated area and volume of soil disturbed was calculated from the linear measurements and/or the height and depth measurements. For foraging pits, an ellipse approximates the shape of the pit and or the soil ejected from the pit. The equation for area is: $K = \pi ab$ (where K =area, $\pi = 3.14159$, a =radius 1 and b =radius 2), and for volume: $V = (\pi/6)(3r_1^2 + h^2 + h^2)h$ (where V =Volume, r =radius and h =height). Shannon-Weiner's diversity index was calculated based on the different species and/or types of disturbance at each plot (Krebs, 1989). The equation is- $\sum (X_1/X_0) \ln(X_1/X_0)$ where X_1 is the number of individuals in species and X_0 is the total number of individuals in the sample. Species richness was also calculated from the total number of different types of disturbances at the plot.

The data were not normally distributed. Therefore, we utilized the Mann-Whitney U -test of mean ranks instead of the t -test. Area, volume and diversity of disturbances were compared between native and Lehmann lovegrass plots at each site for each of the months sampled. The data were also separated by type of disturbance, i. e., the volume and area of soil disturbed by the different categories, for example ants versus termites. These categories of disturbance were also analyzed by the Mann-Whitney U -test to determine if there was more activity at native plots than at Lehmann plots.

4. Results

The cover of Lehmann lovegrass was very different at each of the study locations. (Table 1). The Santa Rita and Pasture sites had distinct differences between the native and Lehmann lovegrass communities whereas the Summerford mountain sites had considerable presence of Lehmann lovegrass at all of the plots although in relatively low percentages.

At the Santa Rita, there was significantly larger area of soil disturbance by animals on the native grass plots than on the Lehmann lovegrass plots (Fig. 2). The volume of soil moved (pit volumes plus mounds of ejected soil) was significantly higher on the native grass plots than on the Lehmann lovegrass plots in March, May, and November (Fig. 2). The total volume of soil moved for all months sampled at the New Mexico study sites was: Pasture Lehmanns— $1.65 \text{ m}^3 \text{ ha}^{-1}$, Pasture Native— $1410 \text{ m}^3 \text{ ha}^{-1}$, Summerford Lehmanns— $31.15 \text{ m}^3 \text{ ha}^{-1}$, Summerford Native— $6 \text{ m}^3 \text{ ha}^{-1}$ and at the Santa Rita study sites: Native $102 \text{ m}^3 \text{ ha}^{-1}$ and Lehmann's

Table 1
Percent cover type by plot and totaled by site

Cover type	NP1	NP2	NP3	LP1	LP2	LP3	All NP	ALP
Bare	48.00	73.50	67.30	10.70	22.56	19.00	62.9	17.4
Grass	41.00	23.29	24.00	12.90	2.19	4.11	29.4	6.4
Lehmann lovegrass	1.36	0.00	0.00	75.00	0.00	71.33	0.5	48.8
Forbs	0.00	0.31	0.00	0.00	69.22	0.00	0.1	23.1
Shrubs	9.63	2.90	8.80	1.40	6.02	5.56	7.1	4.3
	NS1	NS2	NS3	LS1	LS2	LS3	All NP	All LP
Bare	37.8	38.7	24.3	40.4	49.9	32.1	33.6	40.8
Grass	43.2	55.8	70.4	35.7	23.7	36.1	56.4	31.8
Lehmann lovegrass	1.6	0.1	1.7	19.6	10.2	28.0	1.1	19.3
Forbs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shrubs	17.4	5.4	3.5	4.3	16.2	3.8	8.8	8.1
	NSa1	NSa2	NSa3	LSa1	LSa2	LSa3	All NP	All LP
Bare	63.9	62.3	67.0	50.3	52.5	52.9	64.4	51.9
Grass	14.8	17.0	22.5	24.7	2.7	4.5	18.1	10.6
Lehmann lovegrass	0.0	0.7	0.0	0.3	28.5	31.6	0.2	20.1
Forbs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shrubs	16.7	20.0	10.6	24.7	16.3	10.8	15.7	17.3

Plots are (NP) Native Pasture, (LP) Lehmann Pasture, (NS) Native Summerford, (LS) Lehmann Summerford, (NSa) Native Santa Rita, (LSa) Lehmann Santa Rita, (All N) All Native plots and (All L) All Lehmann plots.

lovegrass $10\text{ m}^3\text{ ha}^{-1}$ (Table 2). There were few significant differences in area or volume of soil disturbed by animals at the New Mexico pasture and Summerford study sites (Fig. 2). There were inconsistent differences in diversity or richness (Table 3) of soil disturbances between native grasslands and Lehmann lovegrass dominated grassland. There were no differences in diversity of soil disturbances on plots at the Santa Rita at any of the sampling dates (Fig. 2). Although there were several dates with significant differences in diversity of soil disturbance at the New Mexico Summerford study site, these differences were not consistent between native grass and Lehmann lovegrass plots over time (Fig. 2).

The significant differences in ejecta volumes and rodent burrows between native grassland plots and Lehmann lovegrass plots at the Santa Rita (Fig. 3) were the result of burrow complexes of ground squirrels. Ground squirrels (*Ammospermophilus harrisi* and *Citellus tereticaudus*, (Medina, 1996)) excavated numerous burrow complexes on the native grass plots but were sparse or absent in the Lehmann lovegrass areas. The ejecta soil from the ground squirrel burrow complexes plus small quantities of soil ejected from foraging pits amounted to $18.4\text{ m}^3\text{ ha}^{-1}$ compared to the $0.04\text{ m}^3\text{ ha}^{-1}$ in the Lehmann lovegrass grassland. Volumes of soil moved by ants were higher in the native grassland plots on the Santa Rita except for the June sampling date. There were numerous large nests with large nest entrance cones of fresh soil constructed by leaf-cutter ants (*Atta mexicana*) that were more

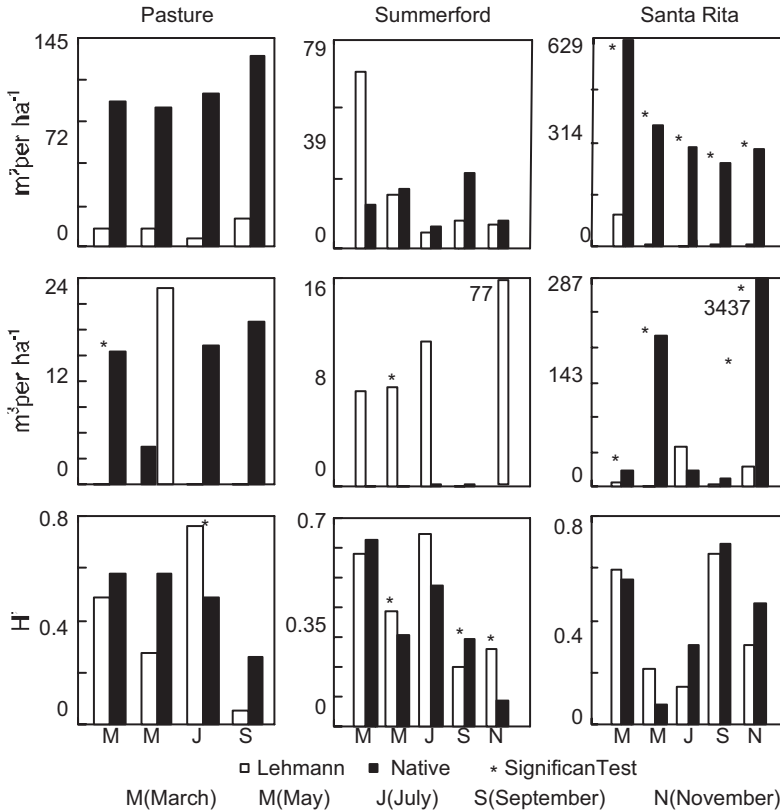


Fig. 2. Mean area, volume and diversity (Shannon's Index) of animal produced soil disturbance of three paired 0.03 ha plots at each location in native grassland and Lehmann Lovegrass grassland. Months in which plots were sampled are: (M) March, (M) May, (J) July, (S) September and (N) November. Means that are statistically different from other means on a sampling date are indicated by * ($p < 0.05$, Mann-Whitney U -test). Data were not collected at the pasture site in November due to a severe increase in grazing intensity.

abundant in the native grassland than in the Lehmann lovegrass plots. Although there were large differences in the volumes of soil moved by ants at the Santa Rita these were not statistically significant because of zero values on some of the plots. Quantities of soil moved by ants on the pasture site in New Mexico were less variable among plots and there were significant differences in volume of ant mounds between native grassland and Lehmann lovegrass dominated grassland. The large seasonal differences in ant activity at the Summerford site and the contagious distribution of ant colonies eliminated any significant differences in volumes of soil moved in the construction of ant nests between native grassland and Lehmann lovegrass grassland at this site (Fig. 3).

There were no consistent patterns of differences in soil disturbance by different animal taxa at the New Mexico sites. The volume of soil disturbed in rodent burrows

Table 2

Cumulative volumes of soil moved by different functional groups of animals and the percent contribution to the total volume of soil moved by animals

	Type	Pasture		Summerford		Santa Rita	
		m ³ ha ⁻¹	%	m ³ ha ⁻¹	%	m ³ ha ⁻¹	%
Native	Ants	4.96	0.35	0.02	0.28	15.93	15.53
Lehmann		0.03	1.84	0.00	0.01	1.63	15.33
Native	Ejecta	0.10	0.01	4.92	81.45	58.64	57.14
Lehmann		0.06	5.55	1.73	5.55	0.23	2.17
Native	Foraging	0.21	0.02	0.51	8.50	1.89	1.84
Lehmann		0.06	3.46	0.67	2.16	0.46	4.34
Native	Rodents	1404.87	99.62	0.54	9.01	13.69	13.34
Lehmann		1.40	84.80	28.75	92.28	8.29	77.72
Native	Termites	0.09	0.01	0.05	0.76	12.46	12.14
Lehmann		0.10	6.18	0.00	0.01	0.05	0.44
Native	Total	1410.24		6.05		102.61	
Lehmann		1.65		31.15		10.66	

Table 3

Richness values for each site by month

	Month	Pasture	Summerford	Santa Rita
Native	March	131	103	146
Lehmann		212	135	128
Native	May	215	169	134
Lehmann		233	225	140
Native	July	146	171	226
Lehmann		124	147	124
Native	September	258	172	91
Lehmann		298	189	165
Native	November	49	53	91
Lehmann			177	99

Richness is the number of animal disturbances per types of disturbances for each site by month samples. Values were used to calculate Shannon-Weiner's diversity index.

was consistently higher on the native grass plots on all sampling dates at the pasture site but was consistently higher on the Lehmann lovegrass plots at the Mt. Summerford site (Fig. 3). The single dates of statistically significant differences in soil disturbance at the New Mexico locations reflected this pattern (Fig. 3). There were also no consistent patterns of soil disturbance resulting from excavation of cache pits or foraging pits nor any consistent patterns in the production of galleries and soil sheeting by termites (Fig. 3).

There were large differences in volumes of soil moved by animals on the Jornada site in comparison to the Santa Rita site. The volume of soil moved by ants, ejected from foraging pits and rodent burrows was considerably higher on the Santa Rita than on the Jornada. The largest volume of soil moved by animals was by rodents in

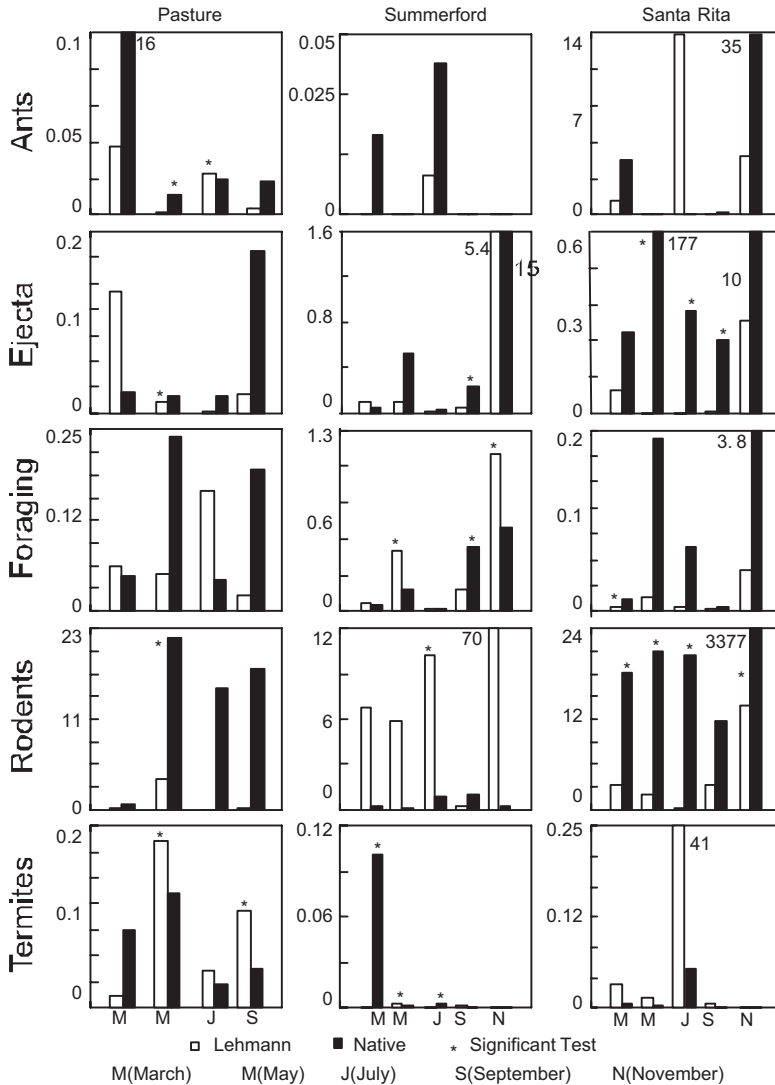


Fig. 3. Comparisons of mean volumes of soil moved for each of the three paired 0.03 ha plots (for display purposes the units are 0.01 m³) by type or animal taxa of soil disturbances in paired Lehmann lovegrass plots and native grassland plots. Statistical significance ($p < 0.05$, Mann-Whitney U -test) indicated by asterisk at a bar. Data were not collected at the pasture site in November due to a severe increase in grazing intensity. Mean values for the 0.03 ha plots are reported for each location and type of disturbance.

the native grassland at the pasture plots on the Jornada. There were several banner-tail kangaroo rat (*Dipodomys spectabilis*) mounds at that site. There were no banner-tail kangaroo rat mounds at any of the other sites. Despite the absence of banner-tail kangaroo rat mounds in the Lehmann lovegrass plots of the pasture site at the Jornada, soil turnover by rodent excavations still accounted for nearly 85% of the

total soil turnover. At the Summerford site on the Jornada, the ejecta mounds produced by pocket gophers (*Thomomys bottae*) accounted for the large contribution of ejecta to total soil turnover at that site. At all sites, soil turnover by vertebrate animals far exceeded that moved by invertebrates.

5. Discussion

Dominance by an alien grass species affected faunalpedoturbation patterns only in areas where Lehmann lovegrass had been established for more than 50 years. Lehmann lovegrass was planted in 1937 on the Santa Rita Experimental Range and approximately 20 years later at the Jornada Experimental Range and the Chihuahuan Desert Rangeland Research Center. Although site specific factors may affect the degree to which Lehmann lovegrass has dominated these different communities, site history appears to be the most important factor. Because Lehmann lovegrass has the ability to dominate and succeed in such a wide range of climatic and edaphic conditions in the south-western United States, the influence of site characteristics is not as evident as length of establishment. Faunalpedoturbation was significantly reduced in areas dominated by Lehmann lovegrass on the Santa Rita Experimental Range. Lehmann lovegrass savanna on the Santa Rita had an effect on species that generate large soil disturbances i.e. ground squirrels and Attine ants. Soil disturbance by these taxa were sparse or absent in Lehmann lovegrass dominated areas but were abundant in native grass savanna. Bock et al. (1986) found that sites dominated by a mixture of native grasses supported a greater variety and abundance of native animals than monocultures of Lehmann lovegrass. Although the plots at the Santa Rita were dominated by Lehmann lovegrass, approximately half of the grass cover was native grass species. The native grass species in the Lehmann lovegrass matrix could have provided the resources necessary to support populations of ant species other than *Atta* spp. and subterranean termites, which would account for the absence of differences in soil disturbance by these taxa. In southern New Mexico, subterranean termites were not reduced in abundance even in areas where grassland had been replaced by mesquite (*P. glandulosa*) coppice dunes (Nash et al., 1999). The subterranean termites of the Santa Rita are generalist feeders and are widely distributed (Haverty et al., 1975; LaFage et al., 1976) and therefore are probably resilient to vegetation change. The abundance and diversity of ants are significantly lower in Lehmann lovegrass dominated areas on the Santa Rita than in areas dominated by native grasses (Whitford et al., 1999).

The differences in quantity of soil moved by animals on the Jornada in comparison with the Santa Rita are attributable to the differences in faunal composition. There are no leaf-cutting ants in the grasslands on the Jornada. Large mounds of the leaf-cutter ant, *A. mexicana*, were abundant in the native grass areas of the Santa Rita. The mounds of *A. mexicana* accounted for most of the soil turnover by ants at the Santa Rita. The ground squirrel species that occupies the desert grasslands on the Jornada, the spotted ground squirrel (*Spermophilus spilosoma*) does not excavate large burrow complexes. The ground squirrels at the

Santa Rita excavated complex burrow systems with as many as 10 entrances in a 3 m radius. Each of the entrances of the ground squirrel burrow complex has a large mound of ejected soil adjacent to the entrance.

There were important differences among sites in the taxonomic groups of animals that accounted for the highest percentage of total soil turnover. Those differences are the result of biogeography and topographic position of the sites on the landscape. For example, on the Jornada–Chihuahuan Desert Rangeland Center, pocket gophers (*T. bottae*) are limited to the grasslands on the upper fan surface of Mt. Summerford and were absent from the Lehmann lovegrass plots, which were on the lower fan surface at the Summerford site. In this example, both topographic position and dominance by an alien grass species affected soil turnover.

The decreased soil turnover resulting from reduced animal excavation in the Lehmann lovegrass plots on the Santa Rita has implications for long-term pedogenic effects. The reduced transport of soil from deep layers to the surface will affect the textural properties and the chemical properties of the soil over time (Johnson, 1990; Whitford and Kay, 1999; Whitford, 2000). While the differences in soil turnover in Lehmann lovegrass and native grass plots on the Jornada were not statistically significant, the absence of some important animals, like pocket gophers in the Lehmann lovegrass areas, suggest that there will be changes in soil texture in the Lehmann lovegrass areas over time. Changes in soil structure may contribute to the reduction in cover and abundance or loss of native plant species from the Lehmann lovegrass dominated areas.

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